US009214798B1

(12) **United States Patent**
Gawron, Sr. et al.

(10) **Patent No.: US 9,214,798 B1**
(45) **Date of Patent: Dec. 15, 2015**

(54) **RANGE INFINITE SWITCH WITH INTEGRAL GFCI SUBSYSTEM**

(71) Applicant: **General Electric Company**, Schenectady, NY (US)

(72) Inventors: **Gregory Francis Gawron, Sr.**, Jeffersontown, KY (US); **Robert John Zanelli**, Louisville, KY (US)

(73) Assignee: **General Electric Company**, Schenectady, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/533,171**

(22) Filed: **Nov. 5, 2014**

(51) **Int. Cl.**

H05B 1/02	(2006.01)
H02H 3/16	(2006.01)
H02H 7/20	(2006.01)
F24C 7/08	(2006.01)

(52) **U.S. Cl.**
CPC ***H02H 3/162*** (2013.01); ***F24C 7/088*** (2013.01); ***H02H 7/20*** (2013.01); ***H05B 1/0266*** (2013.01)

(58) **Field of Classification Search**
CPC H02H 3/162; H05H 7/20; H05B 1/02; H05B 1/0266; H05B 1/0263; H05B 1/0258; H05B 1/0202; F24C 7/088
USPC 219/519, 507, 494, 412, 414, 497
See application file for complete search history.

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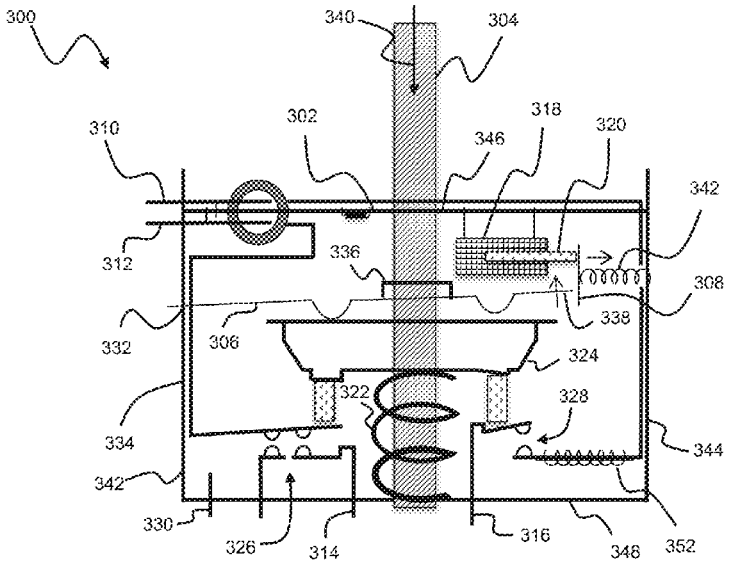
Primary Examiner — Mark Paschall
(74) *Attorney, Agent, or Firm* — Dority & Manning, P.A.

(57) **ABSTRACT**

A range infinite switch including a ground fault circuit interrupter (GFCI) subsystem is provided. The GFCI subsystem operates a solenoid and plunger arrangement that activates a mechanical interlock within the switch permitting axial movement of a cam customarily used to bias temperature controlling contacts within the switch. Upon detection of a ground fault the latching mechanism is released and the cam moves to a position where the temperature controlling contacts are opened so as to disconnect power to a range heating element. In an appliance having more than one heating element, each heating element would be separately protected from ground fault conditions by use of the disclosed switch.

17 Claims, 2 Drawing Sheets



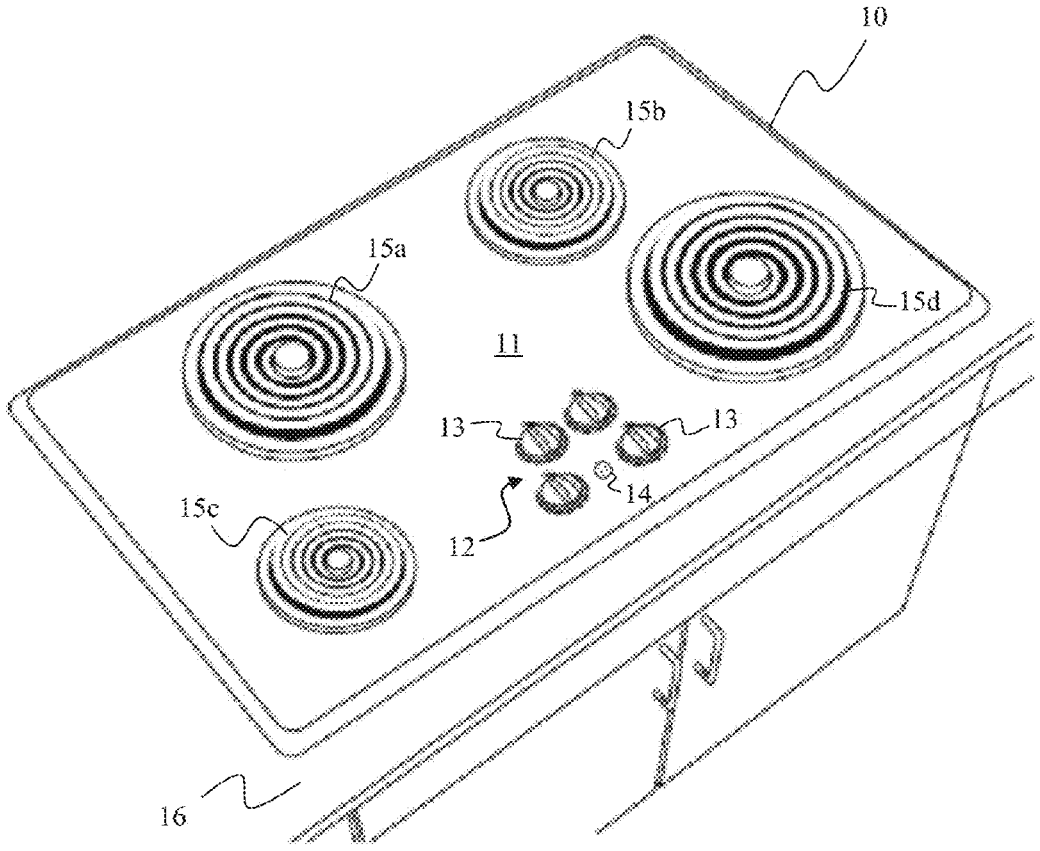
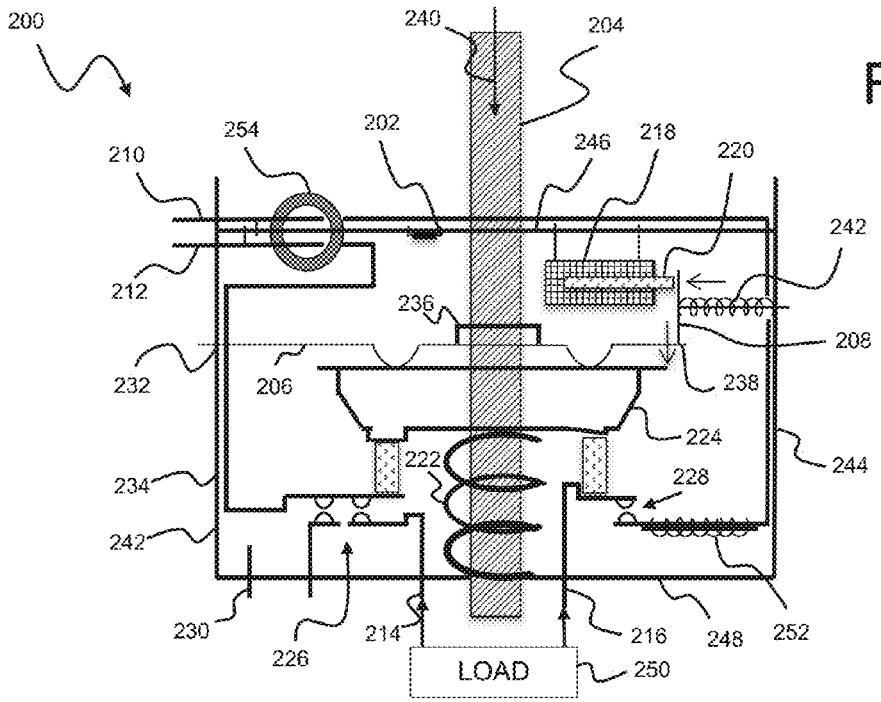


FIG. 1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230
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214
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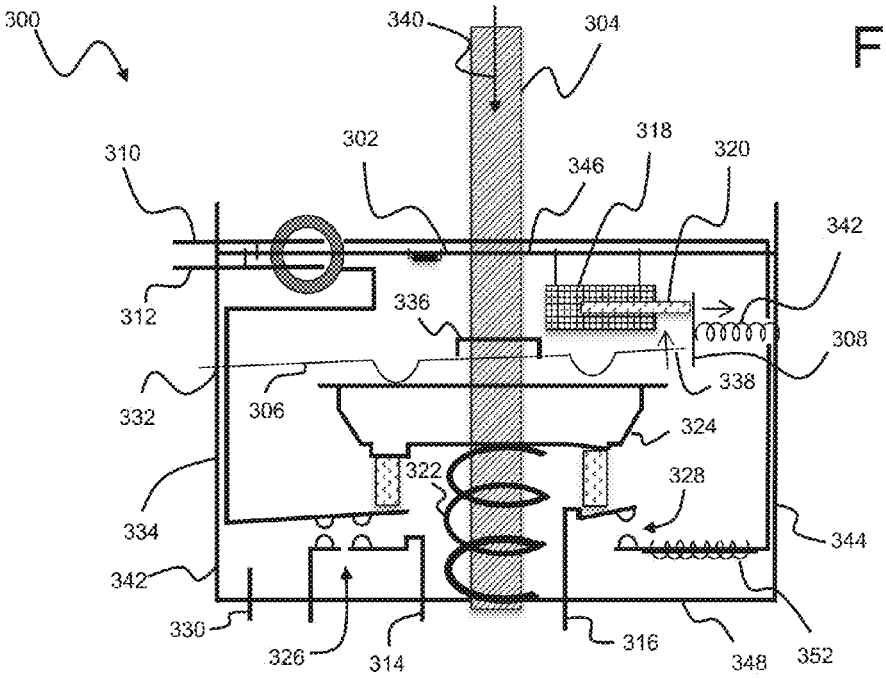
248
252
LOAD
250

FIG. 2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352

FIG. 3

RANGE INFINITE SWITCH WITH INTEGRAL GFCI SUBSYSTEM

FIELD OF THE INVENTION

The present subject matter relates to home appliances. More particularly, the present subject matter relates to improvements in temperature control switches for cooktops, particularly those cooktops employing coil type heating elements.

BACKGROUND OF THE INVENTION

Electric range cooktops employing steel tube and magnesium oxide heaters have a propensity to degrade and short. Depending upon where a short may develop within the coil assembly, a shorting event can lead to excessive energy and molten metal being expelled. Incorporation of a ground fault circuit interrupter (GFCI) device within the cooktop can provide early detection of a short by monitoring for the presence of leakage currents thereby permitting disablement of the load, that is, the heating element, before a high power event occurs.

Advantages obtained through the inclusion of a GFCI device include reducing the risk of element shorting events as well as other undesirable occurrences including potential electric shock of a user or a fire within the cooktop. Often, the cooktop connector system, harnessing, and controls are damaged during occurrence of a high power event. Prior attempts to address these disadvantages have called for employing GFCI circuits utilizing relays in the cooktops which are separate from the traditional infinite control switches. This approach also has disadvantages due to the fact that simultaneous opening of both the power lines in a split-phase mains fed appliance is not assured.

Thus, a need exists for a protective approach that will ensure that both power lines to the heaters will open simultaneously. It would be particularly advantageous to simultaneously disconnect both power lines especially if the GFCI circuit becomes disconnected from only one power line becoming open thus loosing further protection.

BRIEF DESCRIPTION OF THE INVENTION

Aspects and advantages of the invention will be set forth in part in the following description, or may be obvious from the description, or may be learned through practice of the invention.

The present subject matter relates to a range infinite switch having a housing in which is mounted a shaft having a longitudinal axis which shaft is mounted at least partially within the housing for rotational and axial movement. A cam is secured to the shaft for rotational and axial movement therewith and a pair of terminals are provided and configured to be coupled to a source of alternating current (AC). The switch includes at least one pair of contacts positioned for movement between open and closed positions based on movements of the cam. There is also provided a ground fault circuit interrupter (GFCI) circuit board mounted within the housing and configured to monitor current flow through the pair of terminals. A solenoid operable in response to the GFCI is provided along with a plunger operable in response operation of the solenoid. A latching mechanism within the housing is configured to hold the cam in a first axial position until released by operation of said plunger so that release of the cam causes the at least one pair of contacts to separate. In this manner, any load coupled to the separated contacts will be disconnected from power applied to the pair of terminals upon detection of a ground fault.

The present subject matter also relates to a range infinite switch having a housing having a pair of side walls and a pair of end walls. In accordance with an exemplary embodiment, such range infinite switch incorporates a shaft extending through the pair of end walls and mounted within the housing for rotational and axial movement as well as a cam mounted within the housing and secured to the shaft for rotational and axial movement therewith. The range infinite switch also includes at least one pair of contacts positioned within the housing for activation by the cam. In accordance with this embodiment of the present subject matter, a fork is pivotally mounted at one end within a side wall of the housing and extends into the housing and is in contact with the cam for positioning the cam in a first position. A fork retainer is provided and configured to retain the fork in the first position. The range infinite switch further includes a ground fault circuit interrupter (GFCI) board mounted within the housing. The GFCI board including a solenoid energizeable upon detection of a ground fault and a plunger operable upon energization of the solenoid to move the fork retainer to release the fork. Release of the fork permits axial movement of the cam and opening of the at least one pair of contacts.

Embodiments of the preset subject matter further relates to a cooktop appliance. According to such embodiments there is provided a cooktop including at least one heating element and at least one range infinite switch configured to control application of electrical energy to the at least one heating element. In such embodiments the at least one range infinite switch comprises a housing, a shaft having a longitudinal axis mounted at least partially within the housing for rotational and axial movement, and a cam secured to the shaft for rotational and axial movement therewith. Further the at least one range infinite switch includes a pair of terminals configured to be coupled to a source of alternating current (AC) and at least one pair of contacts positioned for movement between open and closed positions based on movements of the cam. In such embodiments, there is also provided a ground fault circuit interrupter (GFCI) board mounted within the housing and configured to monitor current flow through the pair of terminals. The at least one range infinite switch also includes a solenoid operable in response to the GFCI, a plunger operable in response operation of the solenoid and a latching mechanism configured to hold the cam in a first axial position until released by operation of the plunger. In such embodiments release of the cam causes the at least one pair of contacts to separate thereby disconnecting power to the at least one heating element upon detection of a ground fault condition by the GFCI board.

These and other features, aspects and advantages of the present invention will become better understood with reference to the following description and appended claims. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

A full and enabling disclosure of the present invention, including the best mode thereof, directed to one of ordinary skill in the art, is set forth in the specification, which makes reference to the appended figures, in which:

FIG. **1** is a perspective view of a cooktop embodying coil-top cooktop useful in describing one form of the present invention;

FIG. **2** illustrates a schematic representation of a range infinite switch with integral GFCI subsystem in accordance with the present subject matter in an operating position; and

FIG. **3** illustrates a schematic representation of a range infinite switch with integral GFCI subsystem in accordance with the present subject matter in a tripped position.

DETAILED DESCRIPTION OF THE INVENTION

Reference now will be made in detail to embodiments of the invention, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation of the invention, not limitation of the invention. In fact, it will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the scope or spirit of the invention. For instance, features illustrated or described as part of one embodiment can be used with another embodiment to yield a still further embodiment. Thus, it is intended that the present invention covers such modifications and variations as come within the scope of the appended claims and their equivalents.

Generally, the present subject matter is directed to home appliances and, more particularly, to improvements in temperature control switches for cooktops, particularly those cooktops employing coil type heating elements.

It should be appreciated that while the present disclosure is particularly directed to improvements in switches designed in general for use with cooktops, it is also envisioned that such switch may equally be employed with other appliances or devices where protection from ground fault currents in an electrical load is desirable.

Referring more particularly to the presently disclosed subject matter and with reference to FIG. **1** there is shown a cooktop unit **10** comprising a conventional planar glass-ceramic cooktop surface **11** and a control panel **12**, the latter incorporating cooking temperature controls **13**, and indicator lights **14** to indicate the "on" condition of the cooking heaters. A plurality of steel sheathed coil assemblies **15***a*-**15***d* adapted to orient and support cooking utensils during normal cooking operations are provided The cooktop unit **10** is shown in the form of a built-in unit mounted in the counter top **16** of a kitchen cabinet, however, it will be understood that a cook unit incorporating the present subject matter may be embodied in other arrangements such as the cooking surface atop the oven of a free standing range.

With reference to FIGS. **2** and **3** there are illustrated representations of a range infinite switch **200**, **300** with integral GFCI subsystem **202**, **302** in accordance with the present subject matter. FIG. **2** illustrates switch **200** in a normal position, that is, a position where electrical power is applied to a load. FIG. **3** illustrates switch **300** in a tripped position, that is, in a position where electrical power is not applied to a load.

Switch **200**, **300**, in accordance with the present subject matter, corresponds to an assembly which is a combination of a generally traditional "Infinite" switch used for electric range cooktop element level setting combined with a Ground Fault Circuit Interrupter (GFCI) detector and high current circuit deactivator. Examples of such traditional "Infinite" switches are well known in the art as exemplified by U.S. Pat. No. 4,052,591 to Sekera, Jr. et al. It is noted that the switch illustrated by Sekera, Jr. et al. corresponds to a voltage-mode type infinite switch as it includes a heater coil for the bi-metal element couple in parallel with the heating element to be controlled. Those of ordinary skill in the art will appreciate, however, that the present subject matter may also be employed in current-mode infinite switches wherein current flowing through the bi-metal is used as the bi-metal heat source. Likewise, GFCI circuits are also well known in the art as exemplified by U.S. Pat. No. 4,001,646 to Howell and assigned to the assignee of the present subject matter. The present subject matter, however, combines these known devices in a synergistic way along with a high current circuit deactivator mechanism to afford improved electrical fault protection for cooktops.

With further reference to FIG. **2**, in "normal" operation of the cooktop, switch **200** functions as a traditional current-mode infinite switch where the arc, i.e., rotational, position of D-shaft **204** selects between OFF, FULL ON and infinitely variable duty cycle selection in between. If a ground fault is detected in load **250**, switch **200** cuts off the load current via operation of a mechanical interlocking arrangement between fork **206** and fork retainer **208** together with the axial movement of D-shaft **204**, fork **206**, and cam **224** in a direction opposite to arrow **240** causing separation of contact sets **226**, **228** as will be described further later. Once tripped, manual intervention is required to restore normal operation. Generally a reset operation may be performed by pushing D-shaft **204** axially in the direction of arrow **240** so as to allow fork **206** to once again be latched in place by fork retainer **208** while at the same time moving cam **224** in the direction of arrow **240** so as to permit closure of contact sets **226**, **228** when called for depending on the arc (rotational) position cam **224**.

With more specific reference to FIG. **2**, it will be seen that switch **200** generally corresponds to a rectangular housing **234** having generally vertical parallel sidewall portions **242**, **244** and horizontal end wall portions **246**, **248**. FIG. **2** illustrates switch **200** in an operating position, that is, in a position where electrical power is applied to load **250**, that, in this particular case, may correspond to a heating element for a cooktop. Further, switch **200** includes a D-shaft **204** that at least partially extends through end wall portions **246**, **248**. D-shaft **204** is coupled to cam **224** in a manner such that both D-shaft **204** and cam **224** may rotate around the axial direction of D-shaft **204** represented by arrow **240** and to move axially together along the axis illustrated by arrow **240**.

Switch **200** further includes a GFCI circuit board **202** that, in certain embodiments, may correspond in part to end wall portion **246** of housing **234**. Alternative embodiments may provide a further wall portion configured to enclose GFCI circuit board **202** along with the remaining switch **200** components. In an exemplary configuration, GFCI circuit board **202** may correspond to a printed circuit board supporting various components including a current transformer **254** and solenoid **218** all of which are well known in the art and are exemplified by the '646 patent to Howell previously noted. In accordance with the present subject matter, a high current circuit deactivator mechanism is provided by way of the cooperative operation of fork **206**, fork retainer **208**, cam **224** and contact sets **226**, **228**, all activated by the operation of a solenoid **218** and plunger **220** associated with GFCI board **202**.

With continued reference to FIG. **2**, there is illustrated a fork **208** that is pivotally mounted in housing **234** such that one end of fork **206** passes through an opening in side wall portion **242** to provide a fulcrum point **232** for fork **206**. A central length of fork **206** is configured to contact cam **224** and fork end **238** remote from fulcrum point **232** is engaged with fork retainer **208** to hold for **206** in contact with cam **224**

against an a tension force produced by spring **222**. The central portion of fork **206** may be engaged by a securing device **236** to secure fork **206** to D-shaft **204** to maintain fork **206** in proper position and orientation for proper interaction at fulcrum point **232** and cooperative operation with fork retainer **208**. In this configuration, cam **224** may be rotated by way of rotational interaction with D-shaft **204** to operate as a traditional current-mode "Infinite" switch for electric range cooktop element control in cooperation with contact sets **226**, **228** in a well-known manner. Generally, however, infinite switch operates based on rotation of cam **224** that causes contact set **226** to open and close based on "ON" and "OFF" positions of the switch. At the same time contact set **228** is variably biased so that heating of bimetal and heater arm **252** of the contact set must traverse variable distances in order to energize or deenergize load **250**, for example, a heating element.

In normal operation, household alternating current (AC) is applied to terminals **210**, **212**, so that current flow through terminals **210**, **212** is equal. If a path to ground develops in load **250** connected to terminals **214**, **216**, the current flow through terminals **210**, **212** becomes unequal. i.e., unbalanced. This unbalanced current flow is sensed by GFCI **202** in a well-known manner. When a current unbalance is sensed by GFCI **202** circuit, the circuit activates solenoid **218** whose plunger **220** displaces fork retainer **208** against a retaining force produced by spring **242**. Displacement of fork retainer **208** allows end portion **238** of fork **206** to become free and to move upwardly in a direction opposite to arrow **240** along with cam **224** due to the force produced by spring **222**. Movement of cam **224** in a direction opposite to arrow **240** causes contact sets **226**, **228** to open thereby disconnecting any load connected to terminals **214**, **216** from a power source connected to terminals **210**, **212**.

With reference to FIG. **3**, it will be seen that freed fork **306** relieves spring **322** pressure on cam **324**. When cam **324** is relieved, the contact sets **326**, **328** it actuates are unloaded resulting in a spread between the contacts. When cam **324** and contact sets **326**, **328** are no longer under spring **322** tension, contact sets **326**, **328** cannot close to complete a circuit to the load. If the fault is removed or repaired, the mechanism can be reset to normal operating position by pressing on D-shaft **304** in an axial direction, i.e., in the direction of arrow **340**. D-shaft **304** is typically accessible from the front panel of the range as, for example, shown at **13** (FIG. **1**).

In accordance with the present subject matter, the synergistic placement of contacts **226**, **228**, **326**, **328**, cam **224**, **324**, fork **206**, **306**, fork retainer **208**, **308**, springs **222**, **322**, solenoid **218**, **318**, plunger **220**, **320**, and D-shaft **204**, **304** allows proper mechanical sequence for tripping and resetting.

As is common in GFCI circuits, a TEST terminal **230**, **330** may be coupled to GFCI circuit **202**, **302** to provide a means to simulate an unbalanced current. When test terminal **230**, **330** is connected, switch **200**, **300** will trip, i.e., disconnect the heating element after which switch **200**, **300** can be manually reset as described above.

This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they include structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

What is claimed is:

1. A range infinite switch, comprising:
- a housing;
- a shaft having a longitudinal axis mounted at least partially within said housing for rotational and axial movement;
- a cam secured to said shaft for rotational and axial movement therewith;
- a pair of terminals configured to be coupled to a source of alternating current (AC);
- at least one pair of contacts positioned for movement between open and closed positions based on movements of said cam;
- a ground fault circuit interrupter (GFCI) board mounted within said housing, said GFCI board configured to monitor current flow through said pair of terminals;
- a solenoid operable in response to said GFCI;
- a plunger operable in response operation of said solenoid; and
- a latching mechanism configured to hold said cam in a first axial position until released by operation of said plunger, whereby release of said cam causes said at least one pair of contacts to separate.

2. The switch of claim **1**, wherein said latching mechanism comprises a fork pivotally mounted at one end to said housing, extending across said cam to maintain said cam in said first axial position and secured at an opposite end thereof by a fork retained, and wherein said fork retainer is positioned for movement by operation of said plunger.

3. The switch of claim **2**, further comprising:
- a spring mounted in said housing and positioned to apply force to said cam whereby said cam may be moved axially to a second axial position upon release of said latching mechanism.

4. The switch of claim **3**, further comprising:
- a second spring mounted in said housing and positioned to apply force to said fork retainer and plunger, whereby external pressure applied to said shaft may be used to reset cam to said first axial position.

5. The switch of claim **3**, further comprising:
- a terminal coupled to one contact of said at least one pair of contacts and configured to be coupled to a load,
- wherein one terminal of said pair of terminals configured to be coupled to a source of alternating current (AC) is coupled to the other of said at least one pair of contacts,
- whereby movement of said cam to said second axial position causes separation of said at least one pair of contacts thereby disabling AC power from being applied to a load.

6. The switch of claim **5**, further comprising:
- a second pair of contacts positioned within said housing for activation by said cam; and
- a second terminal coupled to said second set of contacts and configured to be coupled to a load,
- wherein another terminal of said pair of terminals configured to be coupled to a source of alternating current (AC) is coupled to the other of said second pair of contacts,
- whereby movement of said cam to said second axial position causes separation of said second pair of contacts,
- whereby a load connected to the other of the contacts of said at least one pair of contacts and said second set of contacts may be disconnected from both said pair of terminals upon detection of a ground fault.

7. A range infinite switch, comprising:
- a housing having a pair of side walls and a pair of end walls;
- a shaft extending through said pair of end walls and mounted within said housing for rotational and axial movement;

a cam mounted within said housing and secured to said shaft for rotational and axial movement therewith;

at least one pair of contacts positioned within said housing for activation by said cam;

a fork pivotally mounted at one end within a side wall of said housing and extending into said housing and in contact with said cam for positioning said cam in a first position;

a fork retainer configured to retain said fork in said first position;

a ground fault circuit interrupter (GFCI) board mounted within said housing, said GFCI including a solenoid energizeable upon detection of a ground fault; and

a plunger operable upon energization of said solenoid to move said fork retainer to release said fork,

whereby release of said fork permits axial movement of said cam and opening of said at least one pair of contacts.

8. The switch of claim **7**, further comprising:

a first spring positioned to bias said fork retainer in a direction to retain said fork in said first position.

9. The switch of claim **8**, further comprising,

a second spring positioned to bias said cam in a direction to open said at least one contact set upon release of said fork.

10. The switch of claim **5**, further comprising:

a pair of terminals configured to be coupled to a source of alternating current (AC); and

a second set of contacts positioned within said housing for activation by said cam,

wherein one contact of said at least one pair of contacts is coupled to one of said pair of terminals, and

wherein a one contact of said second set of contacts is coupled to another of said pair of terminals,

whereby a load connected to the other of the contacts of said at least one pair of contacts and said second set of contacts may be disconnected from both said pair of terminals upon detection of a ground fault.

11. A cooktop appliance, comprising:

a cooktop including at least one heating element; and

at least one range infinite switch configured to control application of electrical energy to said at least one heating element,

wherein said at least one range infinite switch comprises:

a housing;

a shaft having a longitudinal axis mounted at least partially within said housing for rotational and axial movement;

a cam secured to said shaft for rotational and axial movement therewith;

a pair of terminals configured to be coupled to a source of alternating current (AC);

at least one pair of contacts positioned for movement between open and closed positions based on movements of said cam;

a ground fault circuit interrupter (GFCI) board mounted within said housing, said GFCI board configured to monitor current flow through said pair of terminals;

a solenoid operable in response to said GFCI;

a plunger operable in response operation of said solenoid; and

a latching mechanism configured to hold said cam in a first axial position until released by operation of said plunger,

whereby release of said cam causes said at least one pair of contacts to separate thereby disconnecting said at least one heating element from said source of alternating current.

12. The cooktop appliance of claim **11**, wherein said latching mechanism comprises a fork pivotally mounted at one end to said housing, extending across said cam to maintain said cam in said first axial position and secured at an opposite end thereof by a fork retained, and wherein said fork retainer is positioned for movement by operation of said plunger.

13. The cooktop appliance of claim **12**, wherein said at least one range infinite switch further comprises:

a spring mounted in said housing and positioned to apply force to said cam whereby said cam may be moved axially to a second axial position upon release of said latching mechanism.

14. The cooktop appliance of claim **13**, wherein said at least one range infinite switch further comprises:

a second spring mounted in said housing and positioned to apply force to said fork retainer and plunger, whereby external pressure applied to said shaft may be used to reset cam to said first axial position.

15. The cooktop appliance of claim **13**, wherein said at least one range infinite switch further comprises:

a terminal coupled to one contact of said at least one pair of contacts and configured to be coupled to a load,

wherein one terminal of said pair of terminals configured to be coupled to a source of alternating current (AC) is coupled to the other of said at least one pair of contacts,

whereby movement of said cam to said second axial position causes separation of said at least one pair of contacts thereby disabling AC power from being applied to a load.

16. The cooktop of claim **15**, wherein said at least one range infinite switch further comprises:

a second pair of contacts positioned within said housing for activation by said cam; and

a second terminal coupled to said second set of contacts and configured to be coupled to a load,

wherein another terminal of said pair of terminals configured to be coupled to a source of alternating current (AC) is coupled to the other of said second pair of contacts,

whereby movement of said cam to said second axial position causes separation of said second pair of contacts,

whereby a load connected to the other of the contacts of said at least one pair of contacts and said second set of contacts may be disconnected from both said pair of terminals upon detection of a ground fault.

17. The cooktop appliance of claim **11**, comprising:

at least one second heating element; and

at least one second range infinite switch constructed identically to said at least one range infinite switch and configured to control application of electrical energy to said at least one second heating element,

whereby said at least one heating element and said at least one second heating element may be separately disconnected from said source of alternating current.

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